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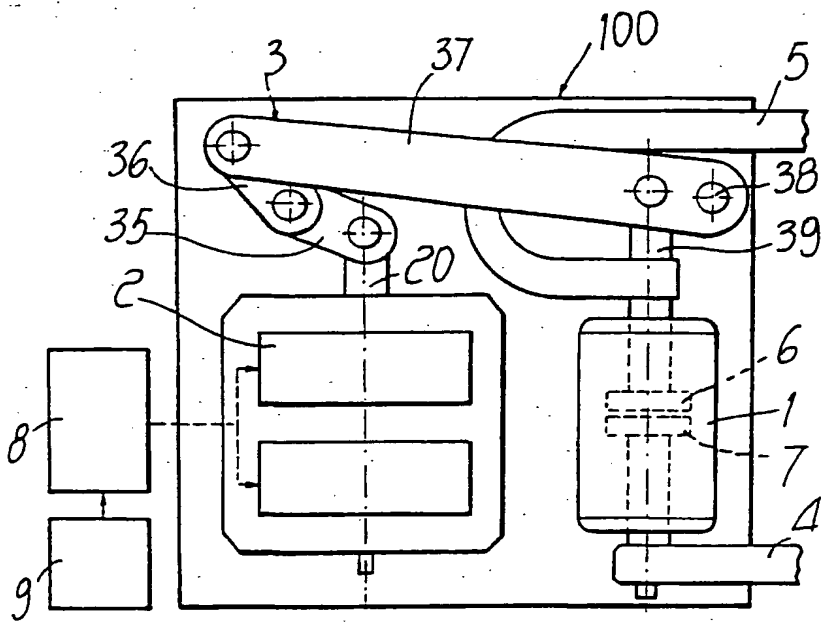
(54) Title: CIRCUIT BREAKER



(57) Abstract: A low-voltage power circuit breaker, comprising a vacuum chamber which contains at least one fixed contact and at least one moving contact which can be mutually coupled/uncoupled in correspondence of a closed/open condition of the circuit breaker, and actuation means which are operatively connected to the moving contact and provide the energy required to move the moving contact and to produce its coupling/uncoupling with respect to the fixed contact, said actuation means comprising an electromagnetic actuator.

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CIRCUIT BREAKER

DESCRIPTION

The present invention relates to a low-voltage power circuit breaker having improved functions and characteristics; more specifically, the expression "low-voltage power circuit breaker" is used to reference a circuit breaker for applications with operating voltages below 1000 Volt.

In general, in low-voltage industrial electric systems in which high currents and therefore high power levels are involved, specific devices, commonly known in the art as automatic power circuit breakers, are normally used.

Said power circuit breakers, which typically operate with AC currents whose nominal operating values, according to the applications, can vary over a wide range, typically from a few hundred to several thousand amperes, are devised to provide some performances which are required in order to ensure the correct operation of the electric power supply circuit that they protect and of the loads connected thereto.

In particular, they protect the loads from abnormal events caused for example by malfunctions related to short circuits or due to overloads by automatically opening said power supply circuit; they allow the correct insertion/exclusion of loads in/from the electric power supply circuit; they ensure that the nominal current for the various connected users is actually equal to the required one, and allow, by manual intervention on an operating lever of said circuit breaker and by corresponding separation of the moving contacts from the fixed contacts, the complete isolation of a load with respect to a power supply source and the consequent disconnection of the circuit that they protect. These power circuit breakers are conceived so as to ensure this performance as well as other features for an intended useful operating life; in particular, according to the prescriptions of the applicable standards, manufacturers define a mechanical life of the circuit breaker, understood as the number of

opening/closure movements that the circuit breaker is capable of performing in the absence of current, and an electrical life, understood as the number of opening/closure switching operations that it can perform in the presence of a current equal to the required nominal value.

Currently there are several constructive solutions for low-voltage power circuit breakers which mainly use two current interruption techniques: i.e., a first technique known as air-insulated interruption, in which the coupling/uncoupling of the contacts occurs in air at room temperature and pressure; and a second technique known as vacuum-insulated interruption, in which the coupling/uncoupling of the contacts occurs in a vacuum ambient. In both interruption methods, the opening/closure switching operations occur by using appropriate actuation devices which are operatively connected to the moving contacts of the circuit breaker and provide the energy required to move said moving contacts and to cause their coupling/uncoupling with the corresponding fixed contacts.

In the current state of the art, the actuation devices used are generally constituted by actuation systems of the mechanical type which use appropriate spring-loaded kinematic systems. The association of said actuation devices with the two interruption methods used, despite allowing adequate execution of the functions required of the circuit breaker, in any case entails some drawbacks and disadvantages.

In particular, circuit breakers with air-insulated interruption and mechanical actuation have a mechanical life which can vary from a few thousand to a maximum of a few tens of thousands of switching operations, and a significantly lower electrical life, mainly due to the formation of intense electric arcs which significantly deteriorate the contacts. In the case of association of the mechanical actuation with the vacuum interruption method, the electrical life increases considerably and reaches in practice the same order

of magnitude as the mechanical life. In both cases, however, in order to ensure the intended mechanical life, it is necessary to program and correctly perform a complex maintenance plan during the use of the circuit breaker, so as to compensate for variations caused by wear and aging which are typical of mechanical systems. Clearly, such a maintenance plan forces the removal of the circuit breaker from active service, the use of labour and the consequent expenditure of time and cost, and becomes particularly onerous in all applications in which it is essential to provide protection against unexpected interruptions, such as for example in process industries.

It should also be noted that actuation devices with spring-loaded kinematic systems are inherently very complicated and bulky; the level of mechanical energy that they must develop is proportional to the various levels of electrical performance of the circuit breaker in which they are used, for example breaking capacity for short circuits, nominal current, et cetera, and requires long and complicated testing and calibration operations.

The aim of the present invention is to provide a low-voltage power circuit breaker which has a longer useful life than known types of circuit breaker and at the same time allows to fully eliminate, or at least significantly reduce, the maintenance interventions required to ensure said useful life.

Within the scope of this aim, an object of the present invention is to provide a low-voltage power circuit breaker whose useful life is considerably longer than in the circuit breakers of the known art and in particular in which the mechanical and electrical life are maximized and have substantially the same value.

Another object of the present invention is to provide a low-voltage power circuit breaker whose constructive architecture is considerably less complicated than known types of circuit breaker.

Another object of the present invention is to provide a low-voltage power

circuit breaker which is highly reliable, relatively easy to manufacture and at competitive costs.

This aim, these objects and others which will become apparent hereinafter are achieved by a low-voltage power circuit breaker, comprising a vacuum chamber which contains at least one fixed contact and at least one moving contact which can be mutually coupled/uncoupled in correspondence of a closed/open condition of the circuit breaker, and actuation means which are operatively connected to the moving contact and provide the energy required to move said moving contact and to determine its coupling/uncoupling with respect to said fixed contact, characterized in that said actuation means comprise an electromagnetic actuator.

In this manner, by using an actuation system of the electromagnetic type and by performing the opening/closure switching operations in vacuum, one obtains the twofold advantage of significantly increasing the useful life of the circuit breaker and of simultaneously eliminating, or at least significantly reducing, the necessary maintenance interventions during the use of the circuit breaker; the actuator of the electromagnetic type is in fact practically immune from the wear and aging problems that are typical of mechanical actuators.

Further characteristics and advantages of the invention will become apparent from the description of a preferred but not exclusive embodiment of a low-voltage power circuit breaker according to the invention, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a schematic view of a low-voltage power circuit breaker according to the invention;

Figure 2 is a schematic view of an electromagnetic actuator which can be used in the circuit breaker according to the invention.

With reference to Figure 1, the low-voltage power circuit breaker according to the invention, generally designated by the reference numeral 100, comprises

an enclosure 1 which is in vacuum and contains at least one fixed contact 7 and at least one moving contact 6. In particular, the vacuum enclosure 1, which constitutes the interruption chamber of the circuit breaker, can be constituted by an appropriately shaped bulb inside which vacuum is maintained; the embodiment of the bulb and the manner in which the vacuum is maintained inside it are widely known in the art and are accordingly not described further.

The fixed contact 7 is electrically connected, by using conventional conducting means 4, for example a copper bar, to a user to be supplied, not shown; in turn, the moving contact 6 is electrically connected, by virtue of conducting means 5, to a power supply line, also not shown in the figure. Said conducting means 5 can be constituted by a plurality of flexible metal strips which are packed together and perforated at their opposite ends, so as to accommodate means for connection to the moving contact 6 and to the power supply line. As shown schematically in Figure 1, according to a solution which is structurally simple and functionally effective, the metal strips are arranged so as to form a substantially U-shaped turn; in this manner, when a short-circuit condition occurs, the two arms of the U-shaped turn are affected by two forces which are orientated in mutually opposite directions and so as to contrast the repulsion forces that are generated during the short circuit and tend to separate the contacts. In this manner, the strips allow to keep the contacts closed for a short initial interval of the short circuit, during which, for example, another circuit breaker possibly included in the power supply network can intervene, thus avoiding untimely interventions and the deactivation of users which could instead continue to operate correctly. Once this interval has elapsed, if no other circuit breaker (if present) has intervened, the contacts separate.

The movements for opening/closing the circuit breaker 100 are performed by

moving the moving contact 6 so as to produce its engagement/disengagement with respect to the corresponding fixed contact 7; the energy required to perform these switching operations is supplied by appropriate actuation means which are operatively connected to the moving contact 6 by virtue of a kinematic chain which is generally designated by the reference numeral 3 in Figure 1. In the embodiment shown in Figure 1, a single pole of the circuit breaker 100 is shown for the sake of simplicity in description.

Advantageously, in the embodiment of the low-voltage power circuit breaker according to the invention the actuation means comprise an electromagnetic actuator 2; the use of an actuator of this type allows to considerably extend the useful life of the circuit breaker, since it does not have the problems of possible wear and/or damage that are typical of mechanical-type actuators, allowing in particular to make the electrical useful life of the circuit breaker practically equal to its mechanical life. Furthermore, the electromagnetic actuator ensures the correct execution of the opening/closure movements of the circuit breaker without requiring any maintenance interventions during its useful life, or at least for a significantly large number of switching operations.

In a preferred embodiment, the electromagnetic actuator 2 is a permanent-magnet electromagnetic actuator. One possible embodiment of the permanent-magnet actuator 2 is described in the European patent application no. 97203501.8, whose description is assumed included herein as reference. In particular, as shown in Figure 2, the permanent-magnet actuator 2 comprises a magnetic yoke 10, an armature 30 which can move within the space formed by the yoke 10, and a pivot 20 which is fixed to the armature 30 and is suitable to transmit the motion to the kinematic chain 3 and therefore ultimately to the moving contact 6.

The movable armature 30 can be shaped in various manners according to the applications and/or specific requirements and can be provided monolithically

and be made of ferromagnetic material or by means of a plurality of stacked magnetic sheets. In turn, the yoke 10 is constituted by two core parts, designated by the reference numerals 40 and 50 respectively, which have an E-shaped profile and are mounted on a suitable support, not shown, so that two air gaps, designated by the reference numerals 18 and 19 respectively, form between them. Two permanent magnets, designated by the reference numerals 26 and 27 respectively, are mounted on the facing surfaces of the two intermediate arms 13 and 23 of the cores 40 and 50; furthermore, two excitation coils 44 and 45 are arranged in the spaces formed between the central arm 13 and 23 and the two end arms, designated by the reference numerals 41 and 22 respectively, of the cores 40 and 50.

In practice, when it is necessary to open or close the circuit breaker, depending on the type of maneuver to be performed, one of the two coils, for example the coil 44, is excited electrically; the excitation energy is supplied to the coil 44 by a power supply unit, schematically designated in Figure 1 by the reference numeral 8, which preferably comprises, according to a solution which is simple, not cumbersome and effective, one or more capacitors which are dimensioned appropriately and are supplied by the electric mains or by an auxiliary source of electric power. The power supply unit 8 is operatively controlled by an electronic command unit 9, which is also connected to the power supply mains; said electronic command unit 9, according to an intervention command which originates for example from a protection system or from an operator, causes the intervention of the power supply unit 8; in this manner the capacitors discharge and energize the coil.

The flux generated by the electrically excited coil allows to overcome the retention force applied by the permanent magnets 26 and 27 to the movable armature 30 and to produce its movement in the direction of said excited coil 44. In this manner, the pivot 20 performs a translatory motion and transmits

the movement to the kinematic chain 3. As shown schematically in Figure 1, the kinematic chain 3 comprises two linkages 35 and 36 which transmit the motion from the pivot 20 to a transmission lever 37; said transmission lever 37, by turning about its pivoting point 38, produces the movement of a coupling pivot 39 which is rigidly coupled thereto and is connected to the moving contact 6; in this manner, the latter moves, consequently realizing the requested operation. Obviously, according to the applications and/or to specific constructive requirements, the kinematic chain 3 can be modified appropriately, for example by varying the number of its constructive components, their relative arrangement and/or their geometric configuration.

Once the operation has been performed, the coil 44 is no longer excited and the permanent magnets resume applying a retention force to the armature 30 keeping it in a stable equilibrium in the position it has reached. An operation in reverse with respect to the above described switching is provided exactly in the same but opposite manner by exciting, in this case, the coil 45.

Clearly, the use of an actuator thus provided allows to significantly simplify the constructive architecture of the circuit breaker with respect to the current state of the art, by eliminating or at least significantly reducing the need of springs and/or of other complicated and cumbersome components; the fact should also be stressed that the use of a vacuum interruption technique does not require excessive switching forces, so that the combination of said interruption method with an electromagnetic actuation produces a synergistic effect which allows to further optimize the geometric and energy sizing of the circuit breaker as a whole, and to reduce testing and calibration operations as well.

Alternatively, it is possible to use an electromagnetic actuator without permanent magnets; in this case, however, the actuator must be provided with a system which is suitable to maintain the pivot 20 in stable equilibrium at the

positions it reaches at the end of the switching operation, differently from what occurs when using permanent magnets, where this function occurs automatically and without using additional components.

For the sake of simplicity in description, Figure 1 illustrates a single-pole circuit breaker; the above described solution can in any case be implemented easily and effectively in the case of a multiple-pole power circuit breaker. In this case, each pole uses a vacuum enclosure 1 which contains at least one fixed contact 6 and at least one moving contact 7. Each moving contact 6 is operatively connected to actuation means which supply the energy required to move said moving contacts and to determine coupling/uncoupling with respect to the corresponding fixed contacts.

In a preferred embodiment, for each pole, a single electromagnetic actuator 2 is provided which is operatively connected to the corresponding movable contact. In this way, it is possible to operate the poles independently from each other. For instance, by suitably programming the electronic command unit 9, it is possible to realize a strategy of switching operations in relation to the phases of the electrical network to which the circuit breaker is connected. In particular, it is possible to use measuring means, such as measuring transformers, which send information about the current and/or voltage trend of the network phases to the unit 9; in its turn, the unit 9, on the ground of the information received, drives the actuators 2 in order to perform synchronized operations for each phase, independently from the others.

This solution results in significant advantages in terms of elimination, or at least significant reduction of voltage and current transients in the network, as well as in terms of limiting electrodynamic and thermal stresses, with significant consequent benefits both for equipment present in the electrical network and the circuit breaker used, considerably increasing its useful life and reliability.

Alternatively, it is possible to use a unique electromagnetic actuator 2, an operating shaft which is operatively connected to said electromagnetic actuator 2 and, for each pole, a kinematic chain 3 which is suitable to connect each moving contact to said operating shaft. In this embodiment, the opening/closure operations of the circuit breaker occurs simultaneously for all the poles, as described above and can be realized in a synchronized way for one phase, which is considered as a reference.

In practice it has been found that the low-voltage power circuit breaker according to the invention fully achieves the intended aim and objects, since its useful life is increased with respect to known types of circuit breakers practically without requiring maintenance interventions, with a consequent benefit in technical and economic terms.

The fact should not be ignored that all the innovative functions and the inventive aspects of the circuit breaker can be achieved by using commonly commercially available elements and materials with very low costs, according to a constructive solution which is simpler and more compact than the known art.

The circuit breaker thus conceived is susceptible of modifications and variations, all of which are within the scope of the inventive concept; all the details may furthermore be replaced with technically equivalent elements. In practice, the materials used, so long as they are compatible with the specific use, as well as the dimensions, may be any according to the requirements and the state of the art.

CLAIMS

1. A low-voltage power circuit breaker, comprising a vacuum chamber which contains at least one fixed contact and at least one moving contact which can be mutually coupled/uncoupled in correspondence of a closed/open condition of the circuit breaker, and actuation means which are operatively connected to the moving contact and provide the energy required to move said moving contact and to determine its coupling/uncoupling with respect to said fixed contact, characterized in that said actuation means comprise an electromagnetic actuator.
2. The low-voltage power circuit breaker according to claim 1, characterized in that said electromagnetic actuator is a permanent-magnet electromagnetic actuator.
3. The low-voltage power circuit breaker according to one or more of the preceding claims, characterized in that it comprises a plurality of flexible metal strips which are electrically connected to said moving contact and to an electric power supply system, said metal strips being suitable, upon a short-circuit condition, to contrast the repulsion force generated between the moving contact and the fixed contact, maintaining said fixed contact and said moving contact coupled to each other at least for an initial step of said short circuit.
4. The low-voltage power circuit breaker according to claim 3, characterised in that said plurality of flexible metal strips are connected to each other so as to realize a substantially U-shaped turn.
5. The low-voltage power circuit breaker according to one or more of the preceding claims, characterized in that it comprises an electronic command unit which, following an intervention command, determines the intervention of a power supply unit which is suitable to supply said electromagnetic actuator.

6. The low-voltage power circuit breaker according to claim 5, characterized in that said power supply unit comprises one or more capacitors.

7. A multiple-pole low-voltage power circuit breaker comprising, for each pole, a vacuum chamber which contains at least one fixed contact and at least one moving contact which can be mutually coupled/uncoupled in correspondence of a closed/open condition of the circuit breaker, actuation means which are operatively connected to said at least one moving contact of each pole and supply the energy required to move said at least one moving contact and to determine its coupling/uncoupling with respect to said at least one corresponding fixed contact, characterized in that said actuation means comprise a unique electromagnetic actuator, an operating shaft which is operatively connected to said electromagnetic actuator, and, for each pole, a kinematic chain which is suitable to connect each moving contact to said operating shaft.

8. A multiple-pole low-voltage power circuit breaker comprising, for each pole, a vacuum chamber which contains at least one fixed contact and at least one moving contact which can be mutually coupled/uncoupled in correspondence of a closed/open condition of the circuit breaker, actuation means which are operatively connected to said at least one moving contact of each pole and supply the energy required to move said at least one moving contact and to determine its coupling/uncoupling with respect to said at least one corresponding fixed contact, characterized in that said actuation means comprise, for each pole, an electromagnetic actuator and a kinematic chain which is suitable to connect each moving contact to the corresponding electromagnetic actuator.

9. A multiple-pole low-voltage power circuit breaker according to claim 7 or 8 characterised in that the opening and/or closing operations are synchronized with respect to at least one of the phases of the electrical

network to which the circuit breaker is operatively associated.

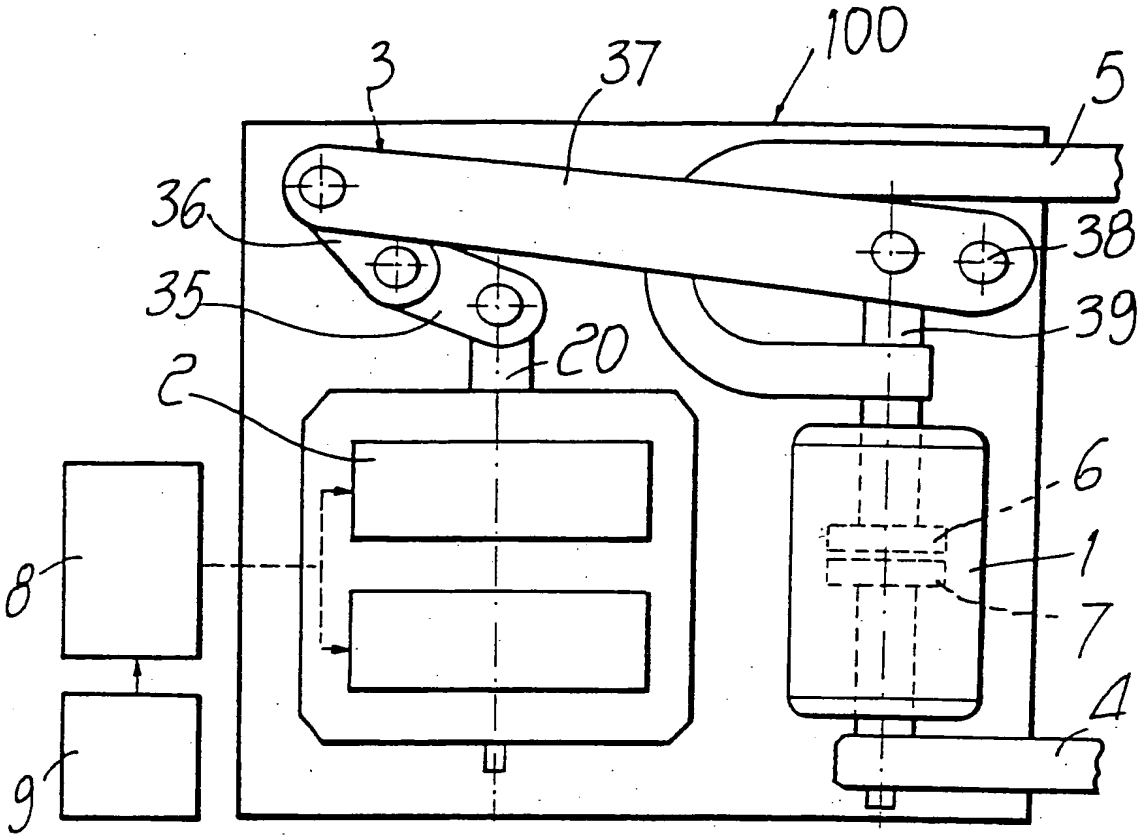
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FIG.1

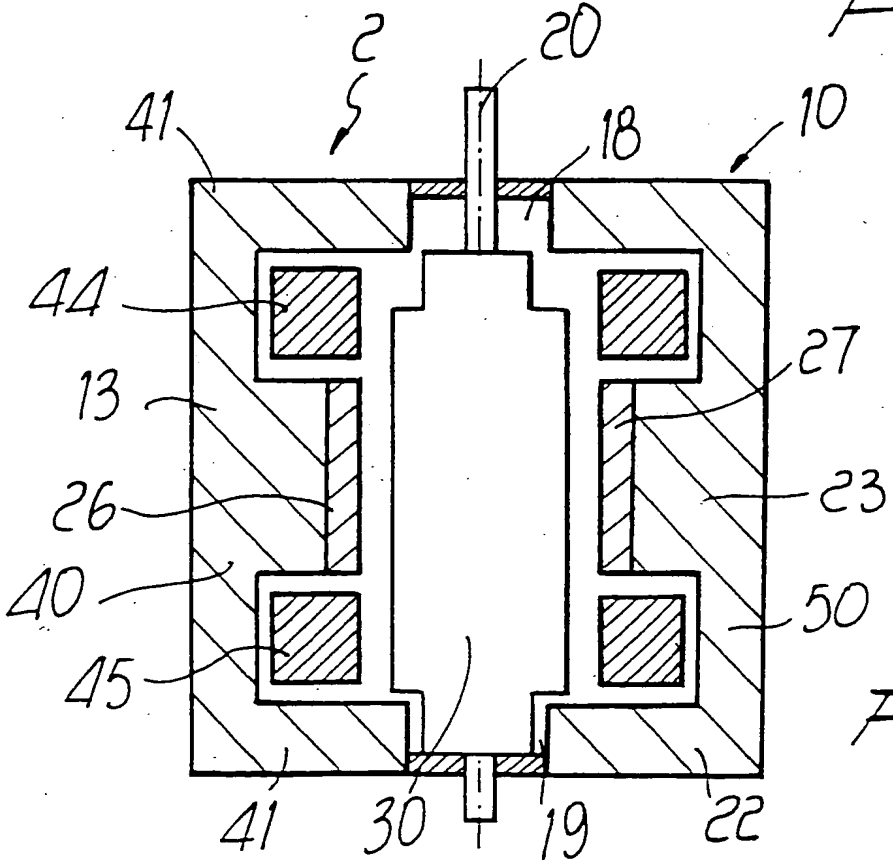
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FIG 2

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(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

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7 June 2001

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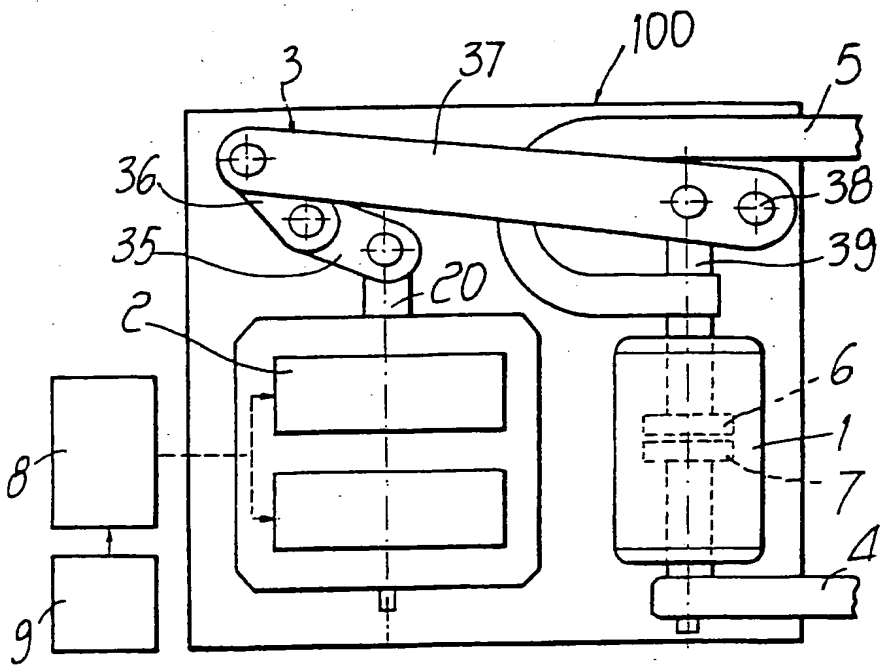
(54) Title: CIRCUIT BREAKER



(57) Abstract: A low-voltage power circuit breaker, comprising a vacuum chamber which contains at least one fixed contact and at least one moving contact which can be mutually coupled/uncoupled in correspondence of a closed/open condition of the circuit breaker, and actuation means which are operatively connected to the moving contact and provide the energy required to move the moving contact and to produce its coupling/uncoupling with respect to the fixed contact, said actuation means comprising an electromagnetic actuator.

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INTERNATIONAL SEARCH REPORT

Inte ional Application No
PCT/EP 00/06263

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01H33/66

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 801 407 A (ABB PATENT GMBH) 15 October 1997 (1997-10-15) column 3, line 1-43; figures 1,3,5	1,2,7,8
X	DULLNI E: "A VACUUM CIRCUIT-BREAKER WITH PERMANENT MAGNETIC ACTUATOR FOR FREQUENT OPERATIONS" IEEE INTERNATIONAL SYMPOSIUM ON DISCHARGES AND ELECTRICAL INSULATION IN VACUUM,US,NEW YORK, NY: IEEE, 17 August 1998 (1998-08-17), pages 688-691, XP000825340 ISBN: 0-7803-3954-1 the whole document	1,2,7,8
X	US 5 912 604 A (SMITH JAMES E ET AL) 15 June 1999 (1999-06-15) abstract; figure 5	1,2,7,8

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 February 2001	01.03.01

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Overdijk, J

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INTERNATIONAL SEARCH REPORT

Inte. ional Application No
PCT/EP 00/06263

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	WO 95 07542 A (KENWORTHY DEREK ;MCKEAN BRIAN (GB); MCKEAN BRIAN ASS LTD (GB)) 16 March 1995 (1995-03-16) the whole document	1,2,7,8
X	EP 0 867 903 A (TOKYO SHIBAURA ELECTRIC CO) 30 September 1998 (1998-09-30) column 10, line 25-50; figure 6 column 15, line 36 -column 16, line 15; figure 15	5,6,9
X	US 3 614 353 A (YOSHIO TOSHIHIKO) 19 October 1971 (1971-10-19)	3
Y	column 2, line 13-73; figure 1	4
Y	US 4 153 827 A (CHARLAS RENE ET AL) 8 May 1979 (1979-05-08) column 4, line 53 -column 5, line 16; figures 7-9	4
A	US 3 663 906 A (BARKAN PHILIP ET AL) 16 May 1972 (1972-05-16) abstract; figure 1	3,4
A	EP 0 871 192 A (ABB RESEARCH LTD) 14 October 1998 (1998-10-14) abstract; figure 1	1,2,7,8
A	DE 43 04 921 C (E I B S A) 25 August 1994 (1994-08-25) abstract; figures 1-3	1,2,7,8

3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP 00/06263

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

As a result of the prior review under R. 40.2(e) PCT, no additional fees are to be refunded.

1. [X] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[X] The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claim : 1 2 7 8

Claims 1, 2, 7 and 8 describe an actuation means for a vacuum circuit breaker, characterised in that said actuation means comprise an electromagnetic actuator.

2. Claims: 3-4

Claims 3 and 4 describe the electrical connection to the movable contact of a vacuum circuit breaker having the special technical feature that this electrical connection comprises a plurality of flexible metal strips, which upon a short-circuit condition contrast the repulsion force generated between the movable and fixed contact, maintaining the fixed and movable contact coupled to each other at least for the initial step of said short circuit.

3. Claims: 5-6

Claims 5-6 describe a vacuum circuit breaker having as a special technical feauture an electronic command unit which, following an intervention command, determines the intervention of a power supply unit.

4. Claim : 9

Claim 9 describes a vacuum circuit breaker having as a special technical feature synchronised opening and closing operation with respect to at least one of the phases of the electrical network to which the circuit breaker is operatively associated.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte ional Application No
PCT/EP 00/06263

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